Space Weather Technical Forecast

Issued on Monday, 17 January 2022 at 01:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1/R2 radio blackouts) throughout. Chance of Active fluence during the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with only C-Class flares over the past 24 hours, with the largest a C2.4 at 16/1945 UTC originating from AR2929. Coronal dimming was evident during this event in imagery, but further coronagraph images are needed to determine if a CME was associated with this event – pending analyse. There are currently seven sunspot regions on the visible disc. AR2929 and AR2930 in the northwest quadrant have the most complexity, with the aforementioned AR2929 producing C-Class flares. AR2932 in the northeast is showing some development with significant areas of flux visible within its large plage region. AR2933 in the southeast is also developing in size and spot number. The remaining sunspot groups are relatively small and simple, though. A CME from the northwest of the Sun on the 15th January may give a weak glancing blow at Earth early on the 17th, although this risk is diminishing. There are no Earth-directed CMEs visible in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds as observed by DSCOVR at L1 are indicative of a high speed stream from CH44/-. Wind speeds started the period at strong levels, with a peak of 642km/s at 16/0249UTC, before declining to elevated levels at around 550-600 km/s throughout much of the period. Density was mostly above average, declining to below average from 16/2130UTC. Total IMF strength, Bt, was mostly weak throughout. The Bz component was also weak, ranging between +6/-5 nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was mainly Quiet to Unsettled, with Active intervals at 16/0000-0300UTC and 16/1800-2100UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout. High energy electron flux (greater than 2MeV) was at background levels initially, increasing to moderate, before exceeding the high threshold (2MeV) from 16/1445UTC, with a peak value of 2280 pfu at 16/1910 UTC, before declining to moderate levels from 16/2010 UTC. Electron fluence remained below the Active threshold (1e8 integrated pfu) with a steady and increasing trend, with 4.82e7 integrated pfu recorded at 17/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate with further C-class flares expected and a chance of M-class flares. Another two regions are expected to rotate on from the far side within the next 24 hours, and this further increase solar activity.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently expected, although one CME is expected to pass close to Earth possibly early on Day 1 (7 Jan), although this risk is diminishing. The solar wind is expected to remain elevated to slightly elevated on Days 1 & 2 (17-18 Jan), with a gradual return to background levels from Day 3 (19 Jan) as the effects of

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CH44 begin to wane. Unsettled to Active periods are likely early on Day 1 (17 Jan), with a slight chance of an isolated G1/Minor Storm still possible at first, due to a diminishing risk of a glancing blow from a weak CME. Geomagnetic activity is then expected to decline to Quiet to Unsettled levels from Day 2 (18 Jan) onwards.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at predominantly background levels. The high energy electron flux (greater than 2MeV) may continue to rise through the period, due to the waning effects of CH44, although the timing and extent is low confidence. Electron fluence may reach Active levels throughout the period.

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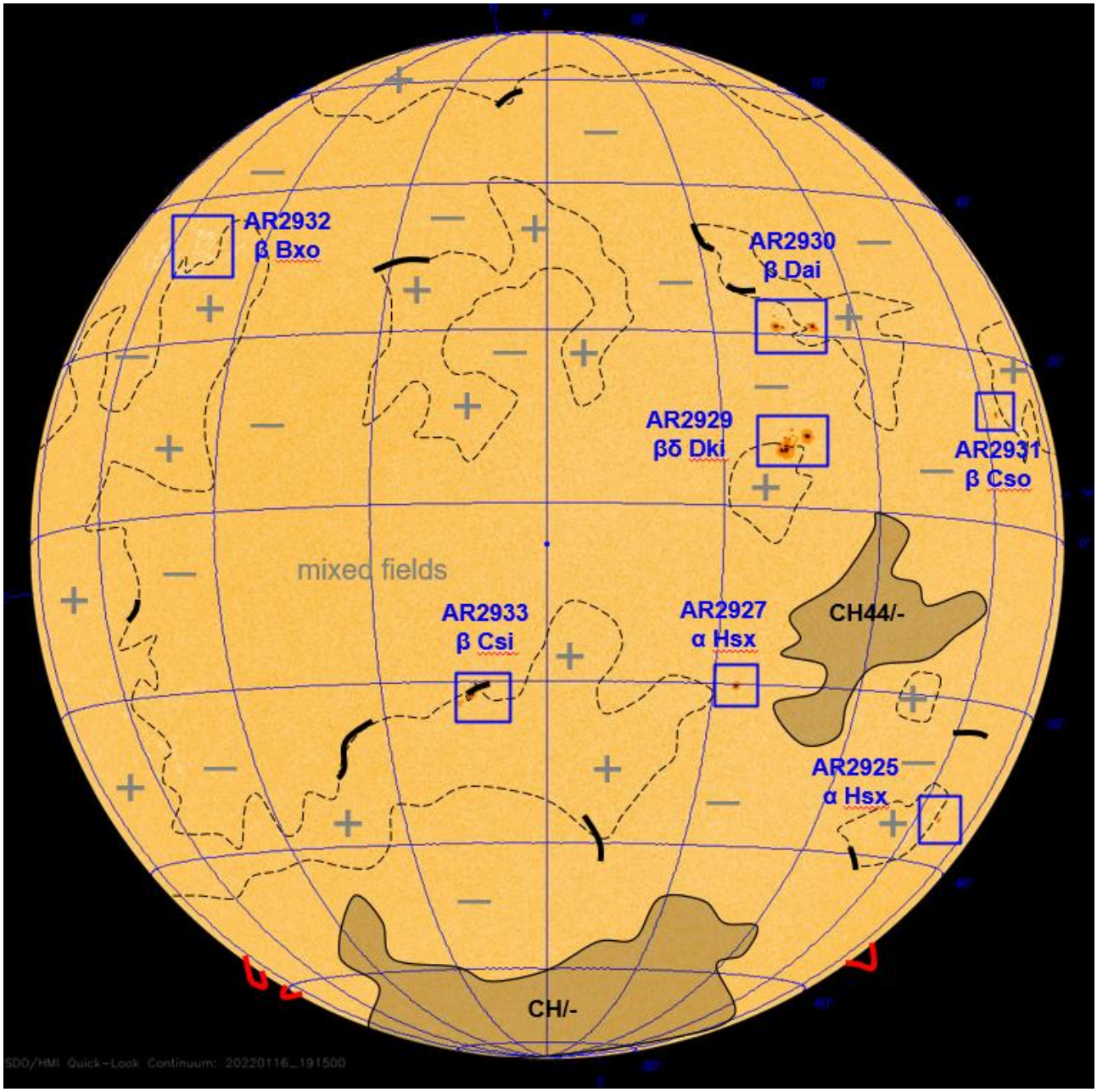
Figure 1. Solar Analysis Valid 16/1915UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME associated with a filament lift-off on the afternoon UTC of the 14th, in the southwest quadrant near AR2925, may give, albeit with a diminishing risk, a glancing blow at Earth early on Day 1 (17 Jan). This was a southward directed CME so the bulk of the ejecta is expected to pass below Earth. Confidence is low regarding this CME, and may not be a feature of the forecast due to its diminishing risk at present, with no evidence in the current DSCOVR solar parameters.

The solar wind speed is expected to continue at elevated levels through Day 1 (17 Jan) and possibly into Day 2 (18 Jan), with speeds between 500-600 km/s. The HSS influence is then expected to gradually decline back to ambient levels from Day 3 (19 Jan).

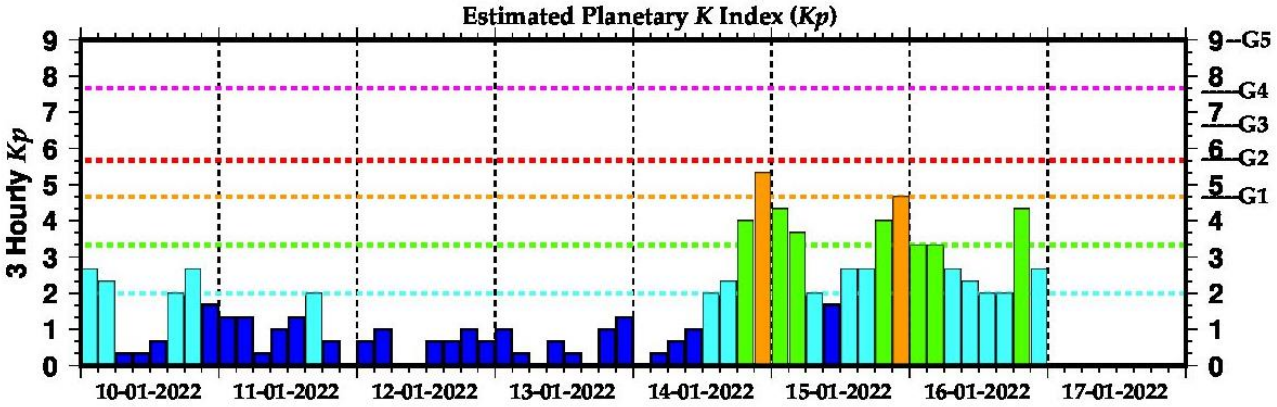
Geomagnetic activity is expected to be Unsettled to Active early on Day 1 (17 Jan) with a slight chance of an isolated G1/Minor Storm due to a possible weak glancing blow from the aforementioned weak CME, although this risk continues to diminish. Geomagnetic activity is expected to decline to Quiet to Unsettled levels from Day 2 (18 Jan).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: BGS Kp index shows recent enhancements due to a fast wind from coronal hole 44.



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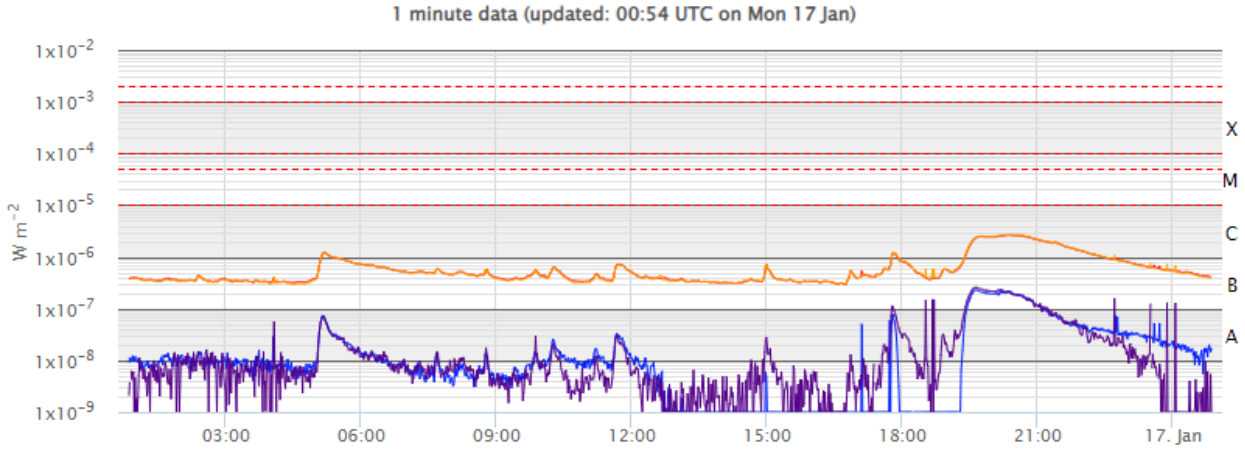
Radio Blackouts - X-Ray Flares:
Solar activity has been Low with only C-Class flares over the past 24 hours. The largest solar flare was a C2.4 observed at 16/1945 UTC originating from AR2929. Coronal dimming was evident during this event in imagery, but further coronagraph images are needed to determine if a CME was associated with this event – pending analyse.

There are currently seven sunspot regions on the visible disc. AR2929 and AR2930 are the two regions most likely to produce a significant flare due to their size and complexity. AR2932 in the northwest is showing some signs of development as is AR2933 in the southeast. The remaining 3 regions are small and stable.

Two further far-side sunspot regions (ex-2916 and 2918) are also likely to rotate onto the disc on Day 1 (17 Jan). This brings a slightly increased chance of M-class flares, and probabilities have been increased during the period to reflect this.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-17 X-Ray flares – shows long period C-class flare originating from AR2929



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) as observed by GOES-16 has returned to background levels. Background levels are forecast to continue barring any significant flares or new Earth directed CMEs in the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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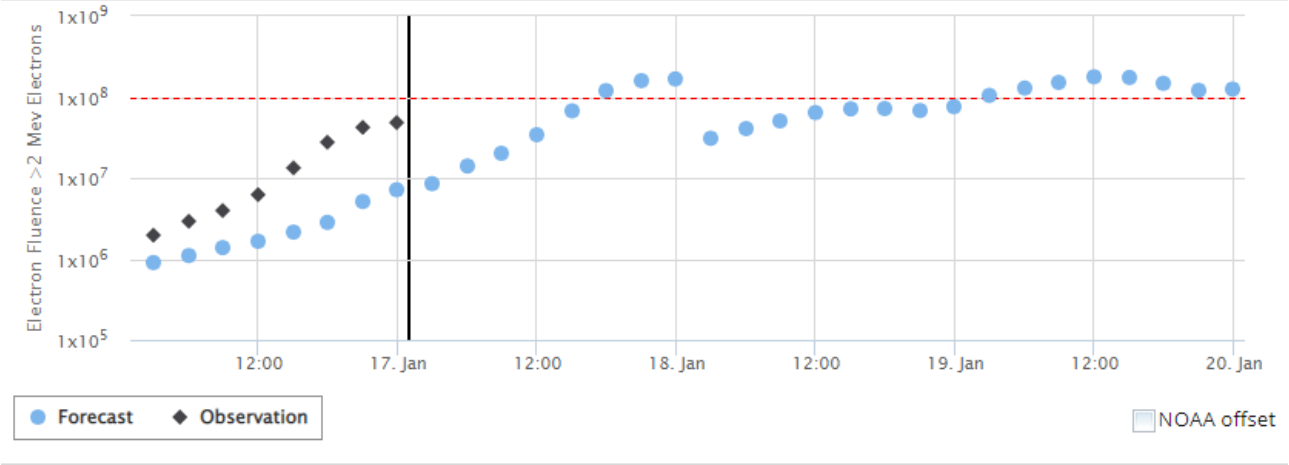
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) was at background levels initially, increasing to moderate, before exceeding the high threshold (2MeV) from 16/1445UTC, with a peak value of 2280 pfu at 16/1910 UTC, before declining to moderate levels from 16/2010 UTC. Flux kevels are likely to continue to rise when the radiation belts decompresses as the HSS of CH44 wanes. This feature on the previous rotation did give an electron response with flux reaching High levels. However, there is still the diminishing possibility of a glancing blow from a weak CME early Day 1 (17 Jan), which may cause an initial suppression in electron levels which means the forecast is low confidence.

The associated 24-hour electron fluence is starting the period at Moderate levels, which may exceed the High threshold early on Day 1 (17 Jan), and possibly continuing at Moderate to High levels throughout the period.

The Met Office REFM output is currently giving reasonable guidance, showing an increasing trend in the fluence levels, with the Chance of reaching Active early on Day 1 (17 Jan) and possibly maintaining a Moderate to High level throughout the period, as the effects of CH44 continue to wane.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	50	50	50	50
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM shows increasing fluence trend during the period.



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